

Objectives

- Examine how **altitude** influences the **risk of pre-eclampsia** in pregnant women
- Apply a **non-parametric modeling approach** that treats altitude as a **continuous variable**, avoiding arbitrary altitude categories and generating nuanced understanding
- Inform **clinical care** and **health policy** in settings where both **altitude** and **maternal health risks** are significant

Introduction

- Pre-eclampsia** affects 2–8% of pregnancies globally, with most deaths in **low- and middle-income countries**.
- Caused by **abnormal spiral artery remodeling**
- Known risk factors** include nulliparity, chronic hypertension, obesity, extreme maternal age, and low socioeconomic status.
- In contrast, role of **high altitude** on pre-eclampsia risk is **understudied** and **unclear**
 - Hypothesized to worsen **hypoxia-related stress** on maternal systems.
- Prior findings are mixed:
 - Colorado study¹: **>2500m** → **33% higher risk**
 - Ecuador study²: **1500–3500m** → **lower risk**, **>3500m** → **higher risk**
- Suggests **non-linear** and **context-specific** effects of altitude.

Methods and Materials

- Study population:** All **hospital births** in Ecuador from **2021–2023** (n = 495,797).
- Pre-eclampsia cases** identified via **ICD-10 codes**
- Geocoded** using **Google Maps API**; **altitude** retrieved via **elevatr** (AWS Terrain Tiles).
 - Accuracy confirmed by comparing to Ecuador **terrain maps** (see FIG 1A&1B).
- Statistical analysis:**
 - Used **chi-squared**, **t-tests**, and **generalized additive models (GAM)**.
 - Results reported as **odds ratios (ORs)** with **95% confidence intervals**.
- Analysis conducted in **R**, following **STROBE guidelines**
- Ethics:** Data was **public**, **anonymized**, and **IRB approval was not required**.

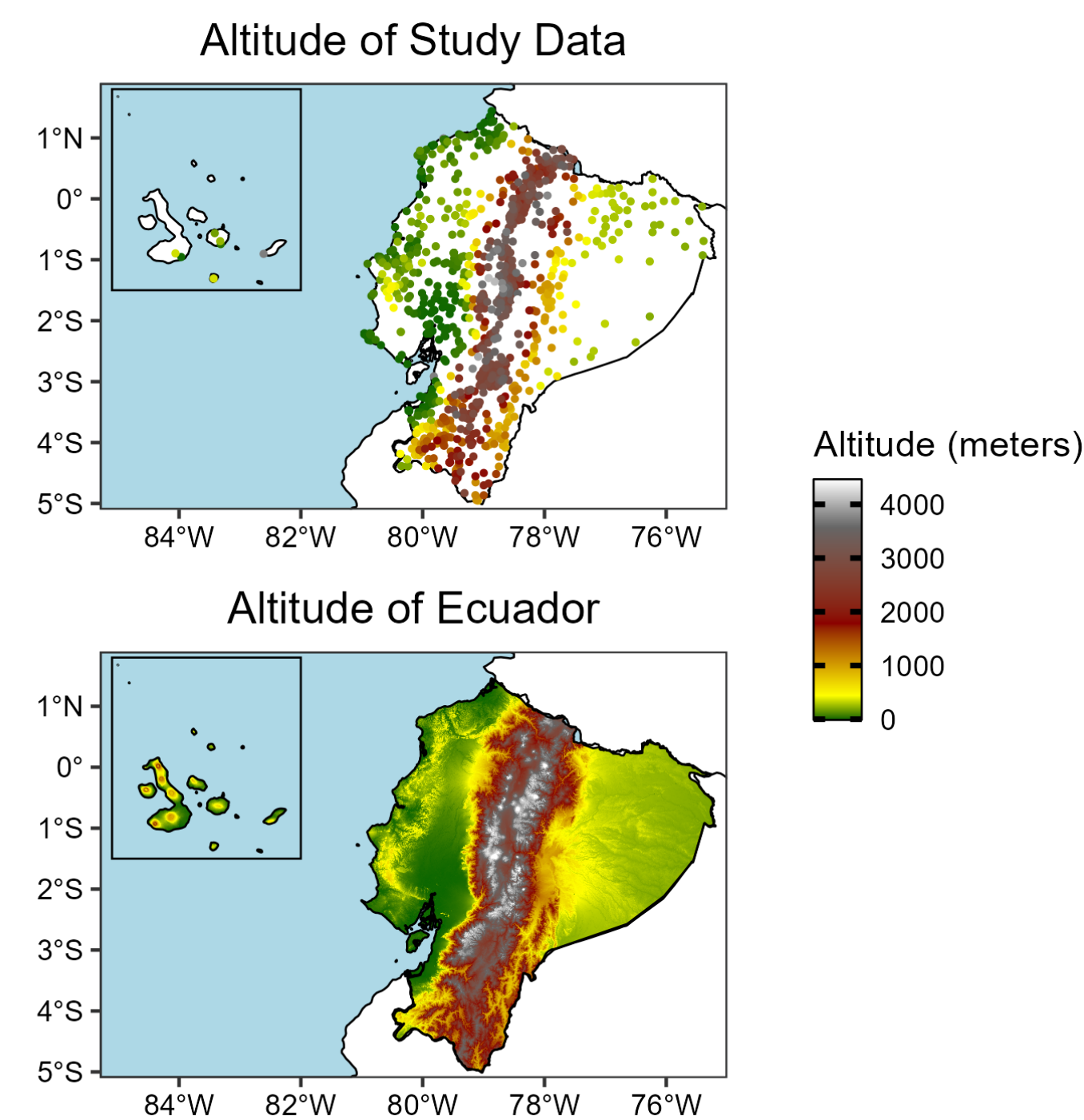


Figure 1A & 1B. Terrain maps of study data and Ecuador

Results

Total births analyzed: 495,797 (2021–2023)
Pre-eclampsia diagnosed in 4.75% of cases (n = 23,537)

Demographic associations:

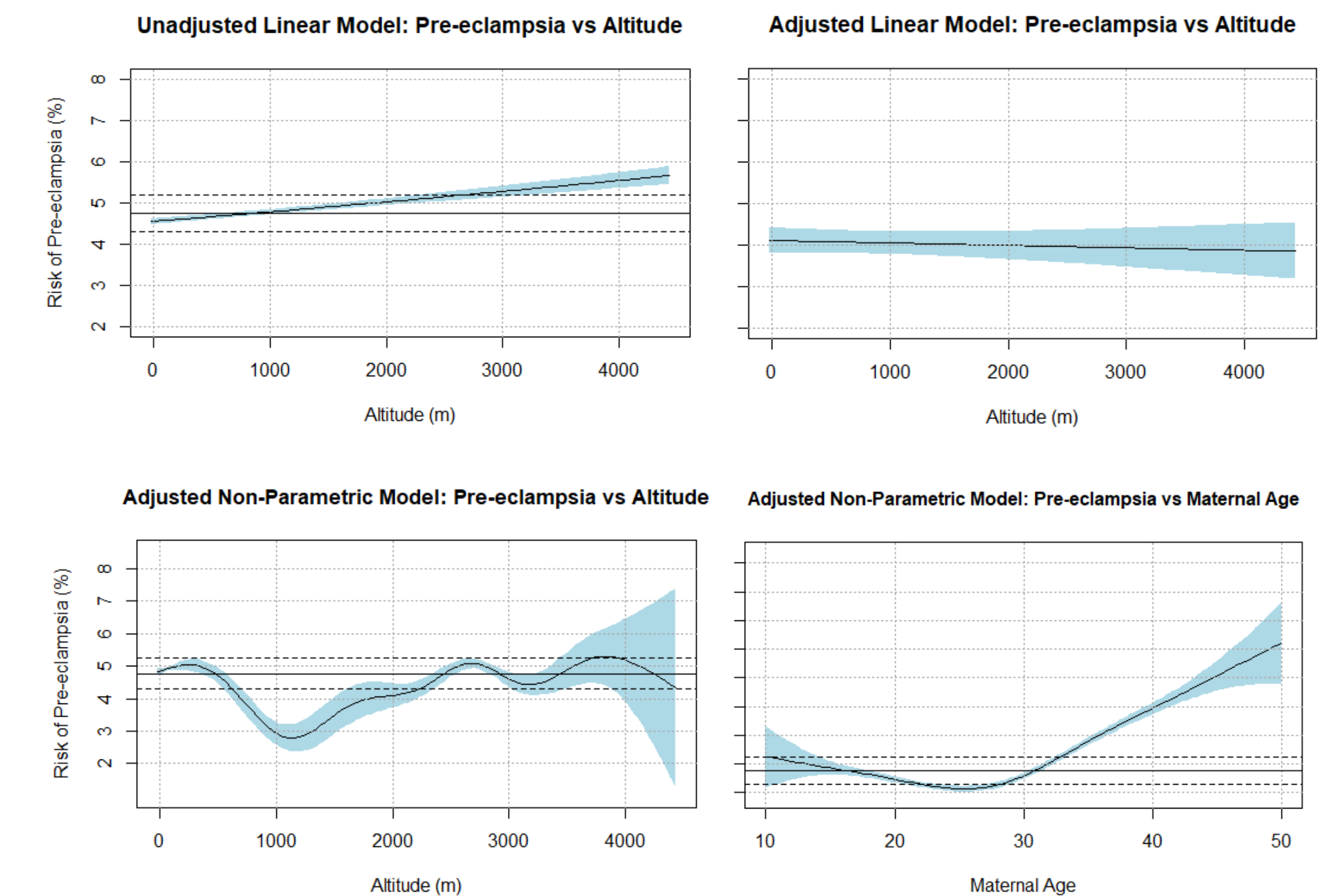
- Public healthcare** users had **>5-fold higher risk** vs private care
- Specialist/general hospitals were linked to higher risk vs clinics/basic hospitals
- Urban vs rural** residence had **minimal differences** in risk
- By ethnicity:
 - Afro-Ecuadorean women had **1.74x higher risk**
 - Andean women had **lower risk** than Mestizan women
- Maternal age was higher** in women with pre-eclampsia (27.0 vs 26.4 years)

In unadjusted models:

- A 2.6% increased odds of pre-eclampsia per 500m
- A non-linear relationship that plateaued above 1800m

In adjusted models:

- Altitude was **NOT associated** with increased pre-eclampsia risk
- Key predictors** were *maternal age extremes, care type, ethnicity, and funding model*
- No significant interaction** between ethnicity and altitude



Conclusions

- No significant association** was found between **altitude** and **pre-eclampsia risk**, after adjusting
- Public healthcare use** and **extremes of maternal age** were the **strongest predictors** of pre-eclampsia.
- There was **no interaction** between **ethnicity** and **altitude**.
- Socio-economic disadvantage** appears to be a more important driver of pre-eclampsia than altitude here.
- Strengths** include **large sample size** and **broad altitude range** of Ecuador
- Limitations** include **lack of individual SES data**, and **absence of key variables** (eg. parity or BMI).
- Findings highlight the need for further research into **social determinants** of pre-eclampsia, particularly in **resource-limited, high-altitude settings**.

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